Citation:

Dove ER, Hodgson JM, Puddey IB, Beilin LJ, Lee YP, Mori TA. Skim milk compared with a fruit drink acutely reduces appetite and energy intake in overweight men and women. *Am J Clin Nutr.* 2009 Jul; 90 (1): 70-75.

PubMed ID: 19474132

Study Design:

Randomized controlled trial with cross-over design

Class:

A - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To investigate the effects of drinking skim milk in comparison with a fruit drink at breakfast on self-reported post-meal satiety and energy intake at lunch.

Inclusion Criteria:

- Men and women
- Overweight but otherwise healthy
- Aged 25–70 years
- BMI of 26-37kg/m^2
- No current major illness such as cancer; non-smoking
- No diagnosed diabetes
- No active psychiatric illness, including an eating disorder
- Consumed breakfast regularly
- Not currently dieting
- Stable body weight (weight change of less than 6% in the previous six months).

Exclusion Criteria:

Description of Study Protocol:

Recruitment

Subjects were recruited through newspaper advertisements.

Design

Randomized controlled trial (RCT) with cross-over design.

Dietary Intake/Dietary Assessment Methodology

- Meals were provided at the research unit
- Breakfast consisted of two slices of toast with margarine and jam (1,923kJ) to be consumed within 15 minutes
- The fruit drink was made up with water from a fruit juice concentrate and contained the same energy as the skim milk (1,062kJ in each)
- Lunch was provided four hours after breakfast (t=240 minutes). The test meal (lunch) consisted of a platter of sandwiches containing fillings that the participant had selected previously. Each participant was provided with sandwiches containing the same combination of ingredients on both testing days. Participants were asked to eat only until they felt comfortably full and were given 30 minutes in which to consume the meal
- Participants were also permitted to consume one 250ml cup of coffee, tea or water two hours after breakfast and with the lunch meal.

Blinding Used

Presentation of intervention meals were randomized, but not blinded.

Intervention

- Consumption of two different drinks during breakfast
- Participants consumed 600ml (1,062kJ each) of either skim milk or fruit drink with a fixed-energy breakfast (1,923kJ) for a total energy intake at breakfast.

Data Collection Summary:

Timing of Measurements

- Participants were asked to maintain their usual diet, physical activity and medication regimens for two weeks before and during the intervention
- Participants were required to stay in the laboratory for this entire length of time
- Participants went between 7:00 and 8:30 in the morning to visit the center after a 12-hour fast
- Participants relaxed for 15 minutes before testing
- Participants consumed 600ml of skim milk or fruit drink with a fixed-energy breakfast
- Participants completed visual analog scales (VAS) ratings of their satiety before breakfast (t=0), throughout the morning (t=30, 60, 120, 180, 210 and 240 minutes), and immediately after lunch (t=270 minutes). VAS served to assess participants' feelings of fullness, satisfaction and prospective consumption throughout the test days.
- Lunch was provided four hours after breakfast (t=240 minutes)
- Participants were asked to eat only until they felt comfortably full and were given 30 minutes in which to consume the meal, after which they again provided a VAS rating of their appetite.

Dependent Variables

- Satiety, feelings of fullness, satisfaction and prospective consumption were determined using visual analog scales. These were taken before breakfast (t=0), throughout the morning (t=30, 60, 120, 180, 210 and 240 minutes) and immediately after lunch (t=270 minutes)
- Total energy intake (kJ) from an ad libitum meal. This was measured by weighing the lunch platters before serving and weighed again when the participant had finished eating.

Independent Variables

Consumption of two drinks, skim milk or fruit drink (600ml, 1,062kJ).

Control Variables

- Age, height, weight, BMI, blood pressure and heart rate were measured
- Blood glucose, total cholesterol, triglycerides, LDL-cholesterol, and HDL-cholesterol were measured from a fasting blood sample
- A study-specific questionnaire was administered to each participant to collect information regarding physical health and use of medications and alcohol and to confirm that the participant was not currently following any particular type of diet in an attempt to lose weight
- Participants also completed the questionnaire version of the Eating Disorder Examination to screen for eating disorders and to ascertain their level of dietary restraint.

Description of Actual Data Sample:

- *Initial N:* N=36 subjects
- *Attrition (final N):* N=34 participants (13 males and 21 females)
- *Age:* 55.1±12.5 years
- *Ethnicity:* Not reported
- *Other relevant demographics:* Not reported
- *Anthropometrics:*
  - Height (m)=1.67±0.1
  - Weight (kg)=90.2±14.4
  - BMI (kg/m^2)=32.4±3.4
- *Location:* University of Western Australia, Perth, Australia.

Summary of Results:

- Participants consumed significantly less energy at lunch after consuming skim milk (mean: 2,432kJ; 95% CI: 2,160, 2,704kJ) than after consuming the fruit drink (mean: 2,658kJ; 95% CI: 2,386, 2,930kJ), with a mean difference of ~8.5% ($P<0.05$)
- Self-reports of satiety were higher throughout the morning after consumption of skim milk than after consumption of the fruit drink ($P<0.05$) with the differences becoming larger over the four hour ($P<0.05$).

TABLE 3. **Mean Self-reported Satiety [as assessed by repeated visual analog scale (VAS) ratings; in mm] In The Four Hours After Beverage Consumption**[1]

Visual Analog Scale	Mean VAS Rating (95% CI)		
Variable	**Skim Milk**	**Fruit Drink**	**Difference**
Fullness	68.9 (64.8, 73.0)[2]	57.8 (53.7, 61.9)	P<0.05
Satisfaction	71.8 (67.4, 76.2)[2]	62.9 (58.5, 67.3)	P<0.05
Prospective consumption	54.0 (48.3, 59.7)[3]	57.4 (51.7, 63.1)	P<0.0001

[1] Data are adjusted for baseline values.

Other Findings

- Correlation analyses indicated that VAS ratings of appetite were more consistently related to subsequent energy intake after consumption of skim milk than after consumption of a fruit drink
- The AUC for the VAS rating of fullness was significantly different between study treatments [10,665 mm per minute (95% CI: 4,571, 9,451 mm per minute) for skim milk and 6,832 mm per minute (95% CI: 4,285, 9,379 mm per minute) for fruit drink; P=0.006]
- Similarly, the AUC for the VAS rating of prospective consumption was significantly different [-5,584 mm per minute (95% CI: -7,275, -3,892 mm per minutes) for skim milk and -2,623 mm per minute (95% CI: -4,445, -801 mm per minute) for the fruit drink; P=0.005]
- The AUC for the VAS rating of satisfaction did not differ significantly.

Author Conclusion:

Consumption of skim milk, in comparison with a fruit drink, leads to increased perceptions of satiety and to decreased energy intake at a subsequent meal.

Reviewer Comments:

This was a well-designed and implemented RCT with cross-over design.

Some comments:

- *Authors conducted several invasive techniques on participants to obtain data that will be used to control for confounders in statistical modeling. The percentage of variability explained by confounders was not addressed in the discussion section. According to the authors, these variables were used to adjust the statistical models. Yet, no discussion on their use was found*
- *The use of area under the curve values for satiety from zero to four hours after breakfast and drinks was reported in the results, Figure 3. Nonetheless, there is no description of the method used to calculate such area or what exactly it represents*
- *Authors used the term slope to describe the relationship between the treatment X time effect. The calculation of these slopes were only briefly, if any, described in the statistical section. These calculations were used to differentiate between non-parallel curves (i.e., those formed from consuming either drink and the VAS response). Although authors assumed a linear model to conduct the analyses, the reviewer does not believe this is correct after the simple inspection of the distribution of the values in the plane. It appears that a quadratic model better fits the comparison, and thus the slopes would have different meaning.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	N/A

3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A	
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A	
4.	**Was method of handling withdrawals described?**	Yes	
4.1.	Were follow-up methods described and the same for all groups?	N/A	
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes	
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes	
4.4.	Were reasons for withdrawals similar across groups?	Yes	
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A	
5.	**Was blinding used to prevent introduction of bias?**	No	
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	No	
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	No	
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	N/A	
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A	
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A	
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes	
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	Yes	
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	N/A	
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes	
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A	

6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A

7. Were outcomes clearly defined and the measurements valid and reliable?   **Yes**

7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	N/A
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes

8. Was the statistical analysis appropriate for the study design and type of outcome indicators?   **Yes**

8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	Yes
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	No

9. Are conclusions supported by results with biases and limitations taken into consideration?   **Yes**

9.1.	Is there a discussion of findings?	Yes

9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes